9 INTELLIGENT VEHICLE SAFETY SYSTEM WITH AUTONOMOUS BRAKING

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1. Problem Statement :

Automatic Emergency Braking (AEB) and Collision Avoidance:

Develop a robust AEB and collision avoidance system that operates effectively in diverse driving conditions, minimizing false alarms while ensuring rapid and accurate detection of hazards. The system should enhance road safety, reduce accidents, and provide drivers with timely intervention to prevent collisions.

Reducing road accidents through an Intelligent Vehicle Safety System with Autonomous Emergency Braking (AEB).

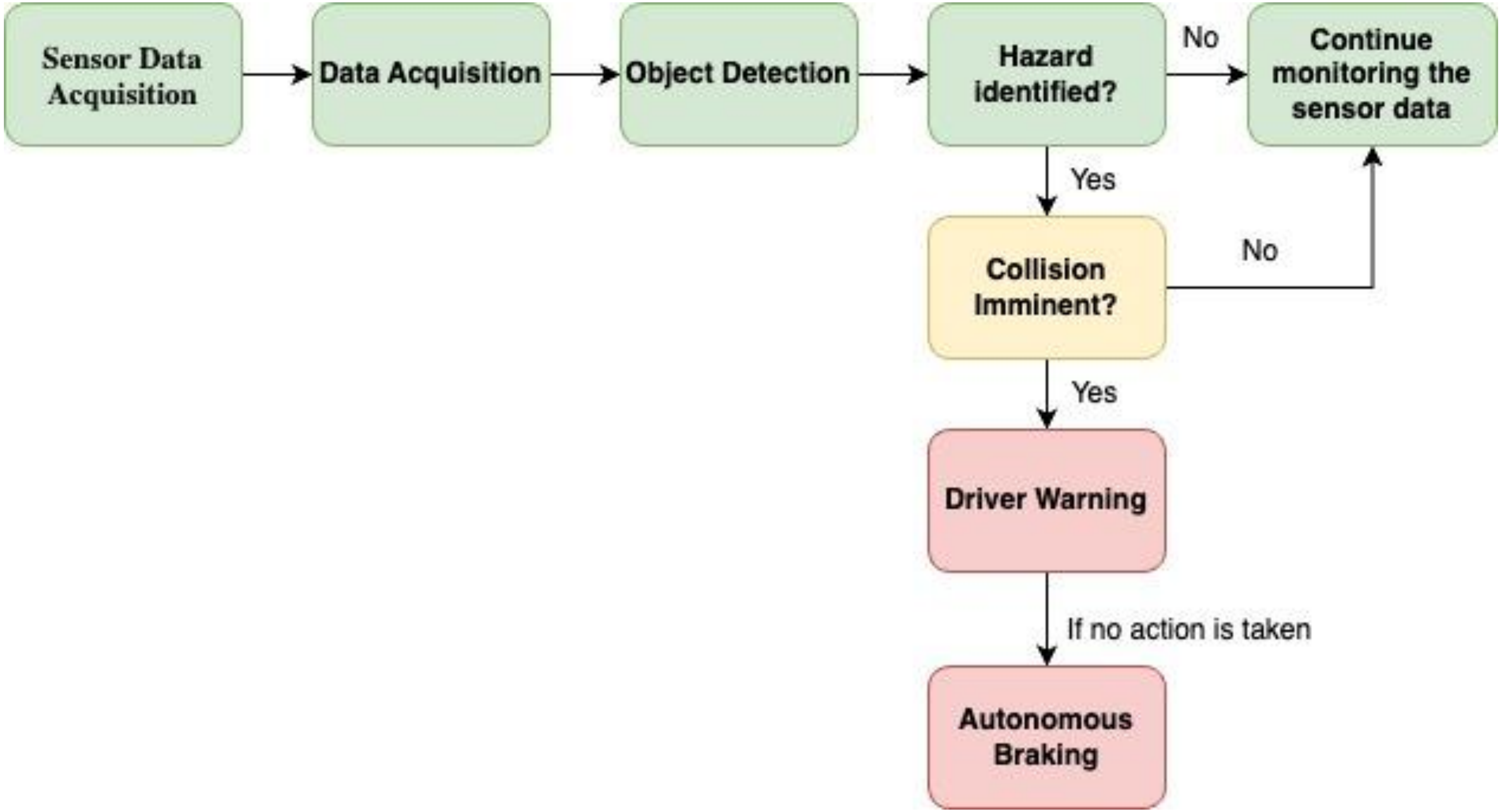
2. Objective and Idea Description

Objective: To create a prototype for an autonomous emergency braking (AEB) and collision avoidance system for real-time obstacle detection and response, using computer vision and proximity sensors. By automatically applying brakes to avoid collisions and sending out timely warnings, the technology will improve road safety.

Idea Description:

- **Proximity and Visual Detection:** Utilizes TF-LUNA Micro LiDAR for proximity detection and the RPi CSI Camera Module for obstacle identification, ensuring detection of both moving and stationary obstacles.
- **Adaptive Obstacle Handling:** During daytime, moving objects are prioritized and stationary objects are considered only in close proximity. During nighttime, both moving and stationary objects are evaluated equally for comprehensive safety.
- **Driver Alerts and Automated Braking:** Issues timely warnings to drivers upon hazard detection. Automatically applies brakes if the driver fails to act, preventing potential collisions.

Working


Sensor Data Acquisition
Data Acquisition
Object Detection
Hazard identified?
No
Continue monitoring the sensor data
Yes
Collision Imminent?
No
Yes
Driver Warning
If no action is taken
Autonomous Braking

3. Innovation

1. **Integrated Sensor Fusion**: The system uses a combination of the TF-LUNA Micro LiDAR Distance Sensor for proximity detection and the RPi Pi 4 CSI Camera Module for visual recognition, creating a robust hazard detection system. This fusion of sensor data ensures comprehensive monitoring of the surroundings in real-time.
2. **Machine Learning for Obstacle Detection:** The Raspberry Pi 4 Model B runs a machine learning model, trained using YOLO and MobileNet-SSD to classify obstacles and predict potential collisions based on camera feed data. This allows for accurate identification of moving and stationary objects.
3. **Adaptive Intervention System:** The system adjusts its intervention level based on the proximity of obstacles. It provides early warnings for distant objects and initiates autonomous braking only when a collision is imminent, ensuring timely and appropriate action while minimizing false alarms.
4. **Real-time Data Processing:** The Raspberry Pi 4 serves as the central processor, leveraging Python, OpenCV, and machine learning models like YOLO or MobileNet-SSD for obstacle detection and classification. The integration of proximity sensor data and visual inputs ensures efficient identification of moving and stationary objects, enabling rapid and reliable safety decisions in real-time.

4. Technicalities and Scope:

Technicalities:

1. **Machine Learning Model:** The system uses YOLO (You Only Look Once) or MobileNet-SSD models for real-time object detection, deployed on the Raspberry Pi 4 Model B. These models classify objects from the camera feed to distinguish between stationary and moving obstacles, enabling the prediction of potential hazards.
2. **Real-time Processing:** Using Python, OpenCV, and TensorFlow, the system efficiently processes camera feed data for obstacle detection and classification. These tools enable fast decision-making, ensuring timely responses to potential hazards.
3. **Autonomous Braking Control:** The system utilizes the L298N Motor Driver to control the DC motor connected to the braking mechanism. When a potential collision is detected and no driver action is taken, the Raspberry Pi 4 processes sensor data (from the LiDAR and camera) and triggers the braking system. The L298N Motor Driver controls the direction and speed of the motor, which is connected to the vehicle's braking mechanism, applying the brakes autonomously to prevent collisions.

Scope:

Future improvements include integrating advanced sensors like radar and ultrasonic sensors for enhanced accuracy. The system could also incorporate updated machine learning models for better hazard detection and classification, adapting to real-time data. Potential expansions involve vehicle-to-vehicle (V2V) communication for enhanced coordination, optimizing performance for various weather conditions, and ensuring compatibility with a wider range of vehicle models. Further refinement of braking algorithms will ensure smoother and safer autonomous braking for improved road safety.

Key Challenges

- **Sensor Fusion and Calibration:** Integrating LiDAR and camera data for accurate obstacle detection and synchronization.
- **Real-time Processing:** Ensuring low-latency data processing for timely decision-making.
- **Obstacle Detection Accuracy:** Handling object classification and detecting hazards in various conditions.
- **Environmental Conditions:** Maintaining performance in different weather and lighting conditions.
- **Speed and Obstacle Calculation:** Accurately measuring vehicle and obstacle speed for collision prediction
- **False Positives/Negatives:** Minimizing false alarms and missed hazard detections.
- **Autonomous Braking:** Ensuring reliable and smooth braking system response.

5. Target Audience/Market

The target audience for Automatic Emergency Braking (AEB) and collision avoidance includes:

- ❖ **Automobile Manufacturers** – OEMs and luxury brands integrating advanced safety features.
- ❖ **Fleet Operators** – Logistics, ride-sharing, and taxi companies prioritizing accident reduction.
- ❖ **Insurance Companies** – Reducing claims and offering incentives for safer vehicles.
- ❖ **Government & Regulators** – Promoting or mandating road safety technologies.
- ❖ **Consumers** – Families, elderly drivers, and tech-savvy buyers seeking safer vehicles.
- ❖ **Tech Companies** – Firms in AI, sensors, or autonomous driving development.
- ❖ **Public Transport Authorities** – Ensuring safety in buses and shuttles.
- ❖ **Safety Advocates** – NGOs and campaigns promoting vehicle safety.

6. Social/Environmental Impact

Social Impact:

- **Enhanced Road Safety:** AEB reduces accidents by automatically detecting and preventing collisions, saving lives and preventing injuries.
- **Support for Vulnerable Drivers:** AEB aids elderly, disabled, or inexperienced drivers by providing additional safety features.
- **Cost Savings:** Fewer accidents lead to lower healthcare costs, reduced insurance claims, and less damage to vehicles.

Environmental Impact:

- **Reduced Fuel Consumption:** AEB helps prevent hard braking, potentially improving fuel efficiency by promoting smoother driving patterns.
- **Decreased Emissions:** By avoiding accidents and reducing fuel wastage, AEB contributes to lower vehicle emissions.
- **Reduced Vehicle Wear:** AEB minimizes damage to the vehicle, extending its lifespan and reducing the need for frequent repairs and resource consumption.

7. Financials

Component	Cost
TF-LUNA Micro LiDAR Distance Sensor for IoT ITS (8M)	Rs. 1,932
Raspberry Pi 4 Model-B with 4 GB RAM	Rs. 5,259
RPi Pi 4 CSI Camera Module 5MP Webcam Support 1080p 720p Video for Pi 4 Model B Pi 3 Model B/B+	Rs. 560
R&d L298n Controller Kit With Dual Shaft Motor, Yellow Wheel Electronic Components	Rs. 579
Total	**Rs. 8330**